Final Exam Physics 1A Friday May 19, 2010

Name:__

Student ID __

Read all the problems carefully and do ones that are easiest for you first. You may use a 3X5 index card but no calculators or cell phones. Show all work. Just writing a solution down with no steps to it will lead to very little credit. Good Luck!

Problem	Score
1. objects on incline plane (20)	
2. strange gravity (25)	
3. moment of inertia (10)	
4. Collision (15) , rocket (10)	
5. Gravity (25)	
6. Pulley (15)	
7. Poem (6)	
Total (126)	

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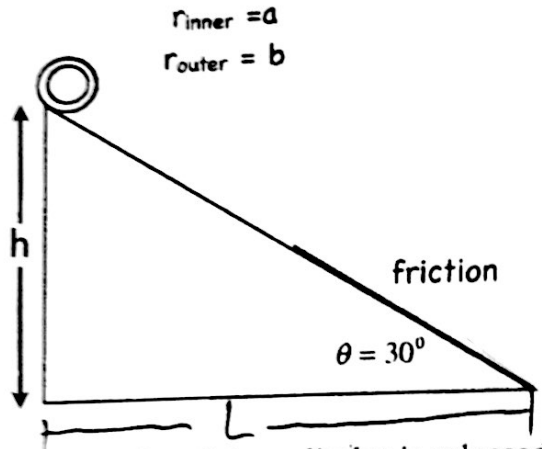
1) Given a cylindrical shell with outer radius b and inner radius a, and length c is at the top of an inclined plane as shown below. The first half of the incline has no friction and the second half does. The coefficient of kinetic friction on the second half is μ and is the same as static friction. The mass density of the shell is ρ.



a) (10 pts)Case I the cylinder is released from the top of the incline and rolls without slipping on the frictional part of the incline. Show the forces on the cylindrical shell on the frictionless and frictional part of the incline. What is the velocity of the center of mass of the cylinder when it gets to the bottom ($v_b(\rho,a,b,h)$, and what is the tangential velocity at the point of contact with the incline)?

b) Case 2 (10 pts) the cylinder is released from the top of the incline and slips without rolling on the frictional part of the incline. Show the forces on the cylindrical shell on the frictionless and frictional part of the incline. What is the velocity of the center of mass of the cylinder when it gets to the bottom and what is the tangential velocity at the point of contact with the incline (r=b)?

Problem 1 continued

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Problem 2

a) On the planet Xergon the force of gravity is not $\vec{F} = -g\hat{j}$, instead it is $\vec{F} = -gy\hat{j}$, where g is a constant.

a) (10 pts) Write and solve the equation of motion for the position of an object as a function of time shot upwards with velocity $\vec{v} = v_o\hat{j}$ at t=0 and solve for the motion. The object goes up, reverses direction and hits the ground much as it does in the gravitation field of the Earth however y(t) is different.

b) (10 pts) How much time will it take for the object to hit the ground?

c) (5 pts) If the initial velocity is $\vec{v} = v_{ox}\hat{i} + v_{0y}\hat{j}$, $v_0 = \sqrt{v_{0x}^2 + v_{0y}^2}$, what is the equation of the position r of the mass as a function of x and the angle θ with respect to the x axis $r(x,\theta,\omega,m,g_0)$?

Problem 2 continued

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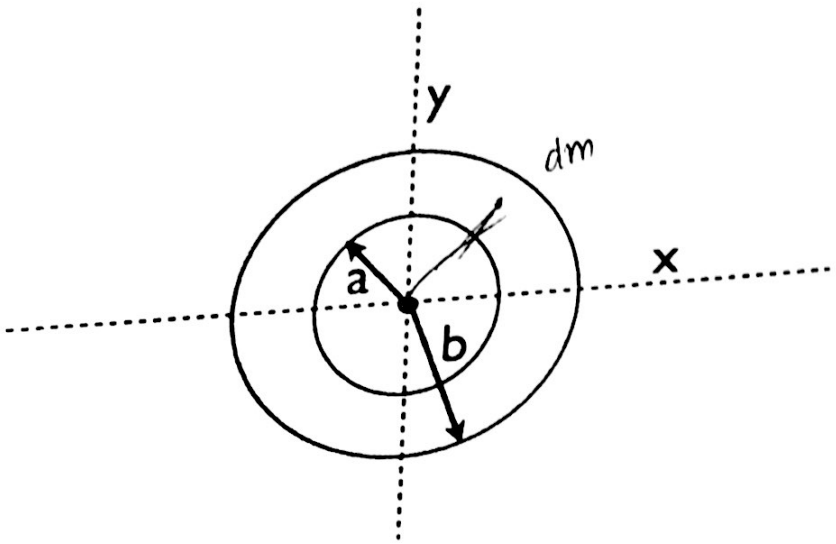
Problem 2

Problem 3

3a) (10 pts) Find the moment of inertia of a 2D circle with a hole in it. The inner radius is r = a , and outer radius r= b. The object spins about an axis through the center (at x=0,y=0). The mass density is given by $\rho = \rho_0 \frac{1}{r} \cos^2\theta$.



Problem 3continued

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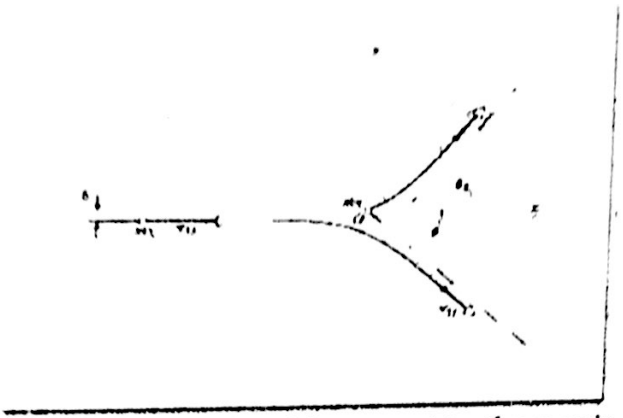
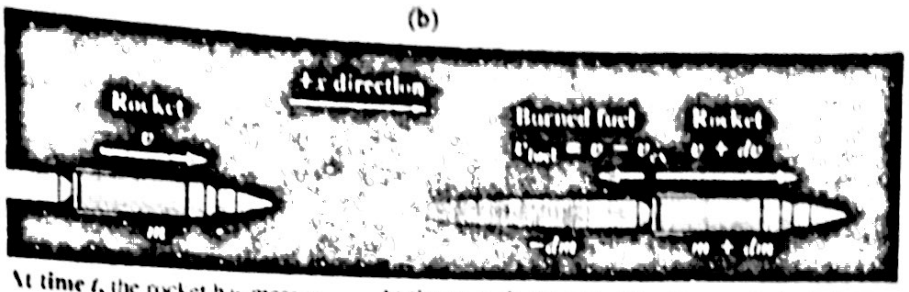
4) Two point masses $m_1 = 2m$, $m_2 = m$, have a collision. Before the collision mass m_2 is at rest and mass m_1 is moving along the x-axis with velocity v_0. After the collision mass m_1 moves at an angle of -30 degrees with respect to its original direction of motion. The collision is elastic.



4a) Find the angle with respect to the x axis (5 pts) that that mass m_2 moves away after the collision. Find the final velocities of both masses (10 pts).

4b) (10 pts)
Given a rocket moving in space where there is no gravitational field. The initial mass of the rocket and fuel is m_1 and the final mass after the fuel has been exhausted is m_2. The initial speed of the rocket is v_0.

8 32 A rocket moving in gravity-free outer space at (a) time t and (b) time $t + dt$



At time t, the rocket has mass m and x-component of velocity v

At time $t + dt$, the rocket has mass $m + dm$ (where dm is inherently *negative*) and x-component of velocity $v + dv$. The burned fuel has x-component of velocity $v_{fuel} = v - v_{ex}$ and mass $-dm$. (The minus sign is needed to make $-dm$ positive because dm is negative.)

Assuming that the product dmdv is small enough to be ignored, find the final velocity of the rocket in terms of m_1, m_2 and v_0.

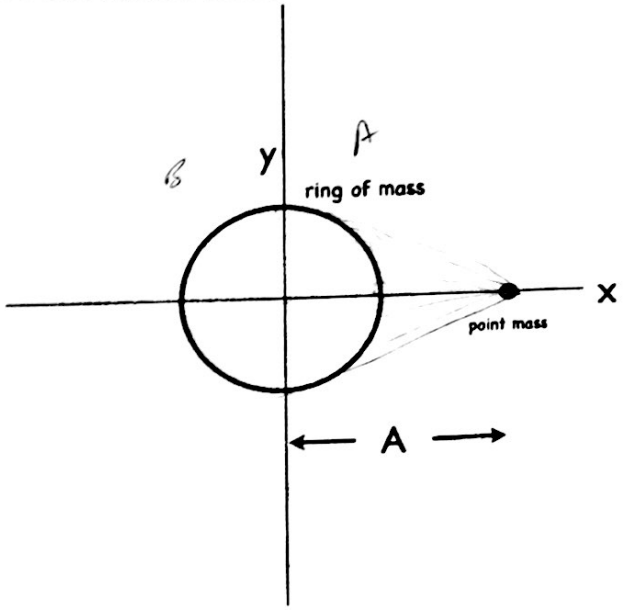
Problem

Problem 4 continued

Problem 5.

5a) (10 pts) Two masses m and M are attracted gravitationally. Mass m is much less than M and orbits around it in circular motion. Prove that for the circular motion that $T^2 \propto R^3$ (One of Kepler's laws) Find the constant of proportionality

b) (15 pts) Given a thin ring of mass with mass density $\rho = \frac{mass}{length}$ and radius R. Find the force on a point mass, m, on the x axis a distance A from the center of the ring, as shown. Hint $dm = Rd\theta$ Do this last its hard!



Problem 5. Continued

Problem 5. continued

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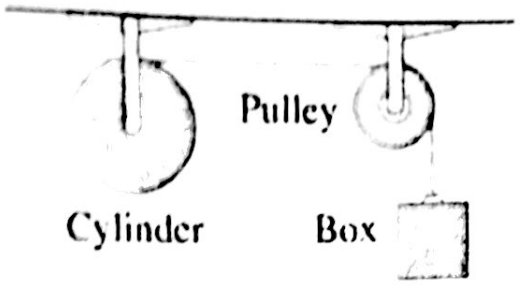
Problem 6 (15 pts) Given the situation shown in the figure below.



A cylinder and pulley turn without friction about stationary horizontal axles that pass through their centers. A mass-less string is wrapped around the cylinder, passes over the pulley and a box of mass m is suspended from it. The cylinder has mass 2M and radius a, and the pulley has mass M and radius b. The box is release. d from rest and descends as the string unwraps from the cylinder. Find the speed of the box after it has descended a distance h.

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Problem 6. Continued